



Testing Flight Hardware

Director's Safety Message

Senior Management ViTS Meeting

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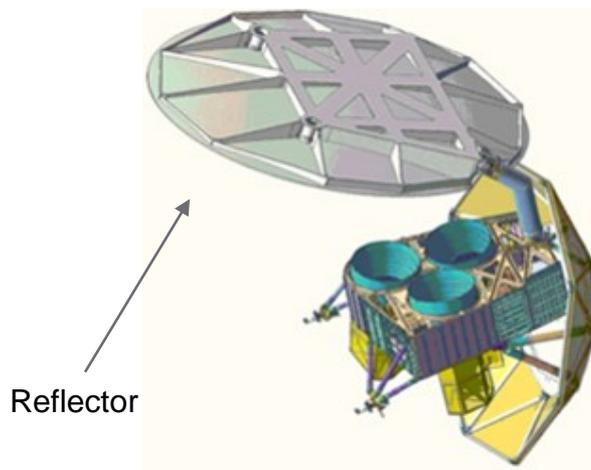
Jet Propulsion Laboratory



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<https://sma.nasa.gov/safety-messages>

Overview

- Aquarius was a radar project managed by the NASA/Caltech Jet Propulsion Laboratory (JPL).
- Aquarius was developed to measure variations in global sea surface salinity for Earth climate studies.
- Two instruments, the Radiometer and the Scatterometer, share a single composite 2.5 meter reflector.
- The reflector acoustic test was planned at the JPL.
- The reflector was damaged during acoustic testing.



Drawing of Aquarius Instrument



Test article suspended in the acoustic chamber

Aquarius Reflector



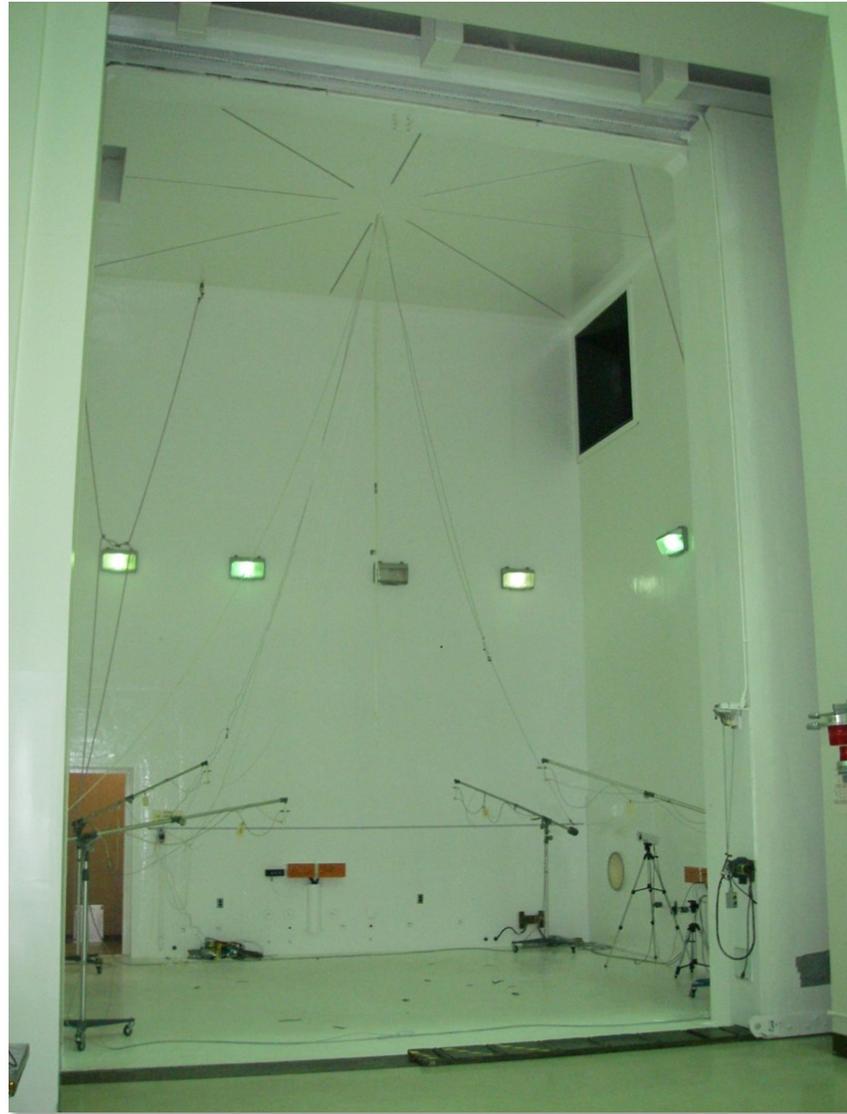
Aquarius reflector being attached to boom

What went wrong

- On May 7, 2007, the JPL Environmental Test Chamber was to perform acoustic testing on the Aquarius reflector.
- A pretest dry run yielded normal results with an EMPTY chamber.
- At beginning of test, the test operator, who was very familiar with the test procedure, was adjusting systems display controls and accidentally hit RUN out of sequence.
- Recognizing this, he hit STANDBY, and attempted to go back and pick up the steps he had missed.
- After hitting RUN again, acoustic test personnel noted the system was in over-test and aborted the test.
- Inspection showed the reflector was damaged.
- The reflector was replaced, resulting in a Class A Mishap.



JPL Acoustic Test Chamber



Findings

Root Cause

- The root cause of the incident was the anomalous behavior of the acoustic test facility caused by deviation from the normal acoustic test procedure.

Proximate Cause

- The control software used in the JPL acoustic control system was not the up-to-date version of the software.
- No acoustic subject matter expert was present during test.

Changes Made

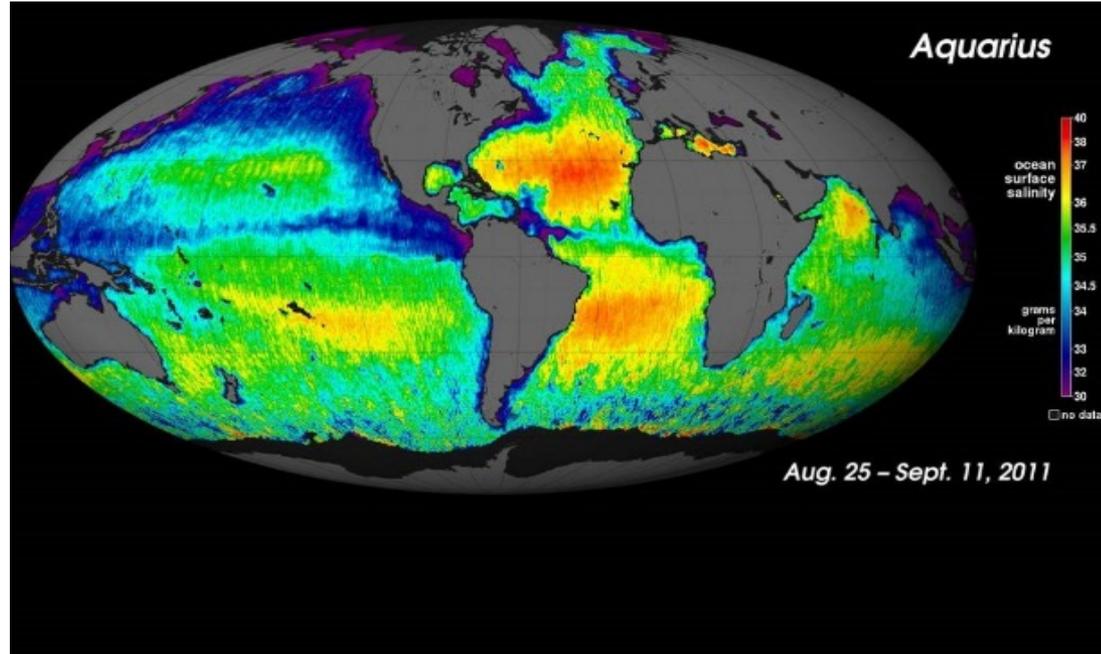
- The control system set-up and monitoring for acoustic testing of flight hardware is checked and verified by a second subject matter expert. In addition, a second party verifies all settings.
- Prior to use of the acoustic test controller, it must be verified that it adequately protects the hardware even when the operator fails to follow the correct procedure. This is now corrected by software updates.
- A record must be made of all critical parameters in the controller software configuration file that are changed or modified, with documentation of who made the changes or why the changes were made, and subject matter expert's approval.

JPL Acoustic Test Chamber Control Center



- Software operates on a PC computer with an interface controller.
- Pressurized gaseous nitrogen (GN₂) is used as a medium for transmitting the noise into the chamber. GN₂ is provided by boil-off from local liquid nitrogen tank.
- The data acquisition area is in the background.

Aftermath



NASA's Aquarius instrument produced this global map of the salinity of Earth's ocean surface, providing an early glimpse of the mission's anticipated discoveries. These global salinity patterns demonstrate Aquarius' ability to resolve large-scale salinity distribution features clearly and with sharp contrast.

Aquarius launched June 10, 2011. After completing its level one requirements, the mission ended June 8, 2015, when power to the attitude control system for the SAC-D spacecraft was lost.

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For more information on the Aquarius Project:
<https://youtu.be/vP4QTyVQTUo>

